CONCLUSION

Current ACCP guidelines miss a substantial proportion of LEDVTs in critically ill trauma patients, especially when CVDVTs are included in the investigation. Routine DUS of all critically ill trauma patients will detect a high number of asymptomatic LEDVTs, 15.2% in our study. Diagnosis of these otherwise undetected DVTs can lead to therapeutic anticoagulation, IVC filter placement, or continued surveillance depending on institutional practices. DUS screening appears to be a useful adjunct to current protocols of DVT prevention, detection, and treatment in trauma ICUs. We recommend early and ongoing surveillance of all critically ill trauma patients for all lower extremity DVTs regardless of injury patterns, DVT risk factors, or the presence of pharmacologic prophylaxis.

AUTHOR CONTRIBUTIONS

Conception and design: AA, SR, RU, GM
Analysis and interpretation: AA, GM
Data collection: AA, JL, SM, RU
Writing the article: AA, GM
Critical revision of the article: GL, GM
Final approval of the article: GM
Statistical analysis: AA, SR
Obtained funding: GM
Overall responsibility: AA

REFERENCES

1. Geerts WH, Code KI, Jay RM, Chen E, Szalai JP. A prospective study of venous thromboembolism after major trauma. N Engl J Med 1994;331:1601-6.
2. Velmahos GC, Nigro J, Tatevossian R, Murray JA, Cornwell EE, Belzberg H, et al. Inability of an aggressive policy of thromboprophylaxis to prevent deep venous thrombosis (DVT) in critically injured patients: are current methods of DVT prophylaxis insufficient? J Am Coll Surg 1998;187:529-33.
3. Geerts WH, Jay RM, Code KI, Che E, Szalai JP, Saibil EA, et al. A comparison of low-dose heparin with low molecular weight heparin as prophylaxis against venous thromboembolism after major trauma. N Engl J Med 1996;335:701-7.
4. Upchurch GR, Demling RH, Davies J, Gates JD, Knox JB. Efficacy of subcutaneous heparin in prevention of venous thromboembolic events in trauma patients. Am Surg 1995;61:749-55.
5. Piotrowski JJ, Alexander JJ, Brandt CP, McHenry CR, Yuhas JP, Jacobs D, et al. Is deep vein thrombosis surveillance warranted in high-risk trauma patients? Am J Surg 1996;172:210-3.
6. Meythaler JM, DeVivo MJ, Hayne JB. Cost-effectiveness of routine screening for proximal deep venous thrombosis in acquired brain injury patients admitted to rehabilitation. Arch Phys Med Rehab 1996;77:1-5.
7. Napolitano LM, Garlapati VS, Heard SO, Silva WE, Cutler BS, O'Neill AM, et al. Asymptomatic deep venous thrombosis in the trauma patient: is an aggressive screening protocol justified? J Trauma 1995;39:651-7; discussion 657-9.
8. Geerts WH, Bergqvist D, Pineo GF, Heit JA, Samama CM, Lassen MR, et al. Prevention of venous thromboembolism: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines (8th edition). Chest 2008;133(6 Suppl):381S-453S.
9. Cippole MD, Wojcik R, Seislove E, Wasser TE, Pasquale MD. The role of surveillance duplex scanning in preventing venous thromboembolism in trauma patients. J Trauma 2002;52:453-62.
10. Spain DA, Richardson JD, Polk HC Jr, Bergamini TM, Wilson MA, Miller FB. Venous thromboembolism in the high-risk trauma patient: do risks justify aggressive screening and prophylaxis? J Trauma 1997;42:463-7; discussion 467-9.
11. Schwarcsz TH, Quick RC, Minion DJ, Kearney PA, Kwolek CJ, Endean ED. Enoxaparin treatment in high-risk trauma patients limits the utility of surveillance venous duplex scanning. J Vasc Surg 2001;34:447-52.
12. Adams RC, Hamrick M, Berenguer C, Senkowski C, Ochsner MG. Four years of an aggressive prophylaxis and screening protocol for venous thromboembolism in a large trauma population. J Trauma 2008;65:300-6; discussion 306-8.
13. Satiani B, Falcone R, Shook L, Price J. Screening for major deep vein thrombosis in seriously injured patients: a prospective study. Ann Vasc Surg 1997;11:626-9.
14. Spinal Cord Injury Thromboprophylaxis Investigators. Prevention of venous thromboembolism in the acute treatment phase after spinal cord injury: a randomized multicenter trial comparing low-dose heparin plus intermittent pneumatic compression with enoxaparin. J Trauma 2003;54:1116-24; discussion 1125-6.
15. Furlan JC, Fehlings MG. Role of screening tests for deep venous thrombosis in asymptomatic adults with acute spinal cord injury: an evidence-based analysis. Spine 2007;32:1908-16.
16. Malinoski D, Jafari F, Ewing T, Ardary C, Conniff H, Baje M, et al. Standard prophylactic enoxaparin dosing leads to inadequate anti-Xa levels and increased deep venous thrombosis rate in critically ill trauma and surgical patients. J Trauma 2010;68:874-80.
17. Borer DS, Starr AJ, Reinert CM, Rao AV, Weatherall P, Thompson D, et al. The effect of screening for deep vein thrombosis on the prevalence of pulmonary embolism in patients with fractures of the pelvis of acetabulum. J Orthop Trauma 2005;19:92-5.
18. Kearon C, Khan SR, Agnelli G, Goldhaber S, Raskob GE, Comerota AJ. Antithrombotic therapy for venous thromboembolic disease: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines (8th edition). Chest 2008;133(6 Suppl):454S-545S.
19. Sharpe RP, Gupta R, Gracias VH, Pryor JP, Pieracci FM, Reilly PM, et al. Incidence and natural history of below-knee deep venous thrombosis in high-risk trauma patients. J Trauma 2002;53:1048-52.
20. Gillet JL, Perrin MR, Allaert FA. Short-term and mid-term outcome of isolated symptomatic muscular calf vein thrombosis. J Vasc Surg 2007;46:513-9; discussion 519.
21. Galanaud JP, Sevestre MA, Genty C, Laroche JP, Zizka V, Quéré I, et al. Comparison of the clinical history of symptomatic isolated muscular calf vein thrombosis versus deep calf vein thrombosis. J Vasc Surg 2010;52:932-8.
22. McLafferty RB, Moneta GL, Passman MA, Brant BM, Taylor LM, Porter JM. Late clinical and hemodynamic sequelae of isolated calf vein thrombosis. J Vasc Surg 1998;27:50-6; discussion 56-7.
23. Meissner MH, Caps MT, Bergelin RO, Manzo RA, Strandness DE Jr. Early outcome after isolated calf vein thrombosis. J Vasc Surg 1997;26:749-56.
24. Saarinen JP, Domonyi R, Zeitlin R, Salenius JP. Post-thrombotic symptoms after an isolated calf deep venous thrombosis. J Cardiovasc Surg (Torino) 2002;43:687-91.

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DISCUSSION

Dr James Watson (*Seattle, Wash*). Dr Azarbal and his colleagues have reminded us that severely injured trauma patients are at increased risk of developing deep venous thrombosis. They screened trauma patients in the ICU without documented signs or symptoms concerning DVT with duplex ultrasound studies. Of those 264 asymptomatic patients, 40 (15%) had evidence of DVT and 25 (63%) of those were calf DVTs. This frequency of DVT is higher than that found by others[1] and is similar to the

16.9% rate found in a systematic review of asymptomatic spinal cord injury patients,[2] a group at higher risk for DVT than trauma patients.

It is not surprising that they found older patients and those with a lower admission Glasgow Coma Score were more likely to suffer a DVT and subsequently spend more time in the ICU than those who did not develop a DVT. It is surprising that high-risk injuries and higher injury severity scores did not correlate with a higher risk of developing DVT.

Another unexpected finding was that the prophylactic administration of low molecular weight heparin did not provide any protection against the development of DVT. We are not provided any data about the timing of prophylaxis initiation or how frequently anticoagulation was interrupted, either of which may interfere with the efficacy of prophylaxis. It has been shown that prophylaxis can safely be started within 36 hours of injury and need not be interrupted for most surgical procedures due to concern over excess bleeding.[3]

Cost data is of paramount importance in this economic climate. The authors appropriately point out that Meythaler showed the cost per year of life saved for duplex scanning of brain injured patients was only $2977,[4] which is less than the cost of mammography or fecal occult blood testing. The cost of "screening" for asymptomatic patients is significant. I suspect we will, and should, see a lot more specific economic data such as the "incremental cost effectiveness ratio" of duplex scanning for various clinical situations in the near future. Providing good patient care is not enough anymore. We need to ensure that what we do is not only medically necessary but also that it makes economic sense for society.

I have several questions for the authors:

What is your current protocol for DVT prophylaxis in trauma patients? Have you changed your recommendations in favor of more aggressive prophylaxis? Do you think chemical prophylaxis should be altered for operative procedures?

Dr Amir Azarbal. Thank you for your comments, Dr Watson. Our current protocol is to start prophylactic dose LMWH at 30 mg SC bid as upon admission to the trauma ICU, unless there is a contraindication. The decision to interrupt LMWH prophylaxis for procedures is left to the discretion of the surgeon performing the procedure. Most general surgical procedures are done without interruption of the prophylaxis, while orthopedic and neurosurgical procedures are more likely to result in a halting of prophylaxis.

As for recommendations for more aggressive prophylaxis, we have an ongoing study evaluating factor Xa levels and other objective measures of anticoagulation to help determine optimal levels of LMWH prophylaxis in trauma patients. However this study is still in its preliminary stages.

Dr Watson. How do you decide which asymptomatic patients need weekly scans? Do you only scan patients in the ICU or do you also include other high-risk patients with limited mobility who may be in intermediate-care units or even on the regular ward?

Dr Azarbal. Currently, we scan all patients in the trauma ICU weekly. Duplex ultrasound screening of ward patients considered to be at high risk for developing DVTs is performed at the discretion of the trauma service attending and not done based on protocol.

Dr Watson. Does your lab get paid for screening venous duplex examinations in asymptomatic patients?

Dr Azarbal. No, screening studies are not currently reimbursable and are done as part of a study protocol. Hopefully, with cost-effectiveness data, such as the study by Meytheler et al[4] screening studies will become reimbursable in the future.

Dr Watson. Are there any other tests you find useful in detecting DVT? Specifically, would a positive or negative D-dimer assay have any effect on your decision to obtain, or not obtain a duplex examination in an asymptomatic patient?

Dr Azarbal. D-dimer assays have been helpful due to their high negative predictive value in medical patients. However, in the acute trauma setting the D-dimer assay can have a high false negative rate.[5] Therefore, given the high DVT rate of the trauma ICU population, I do not believe a normal D-dimer assay would be assuring enough to preclude duplex ultrasound screening. D-dimer assays may have more of a role in continued surveillance of trauma patients as the time from injury increases.[5] Conversely, D-dimer assays are often elevated in trauma patients; and therefore, I do not believe a positive D-dimer assay using current accepted values would be helpful.

REFERENCES

1. Fowl RJ, Strotham GB, Blebea J, Rosenthal GJ, Kempczinski RF. Inappropriate use of venous duplex scan: an analysis of indications and results. J Vasc Surg 1996;23:81-6.
2. Furlan JC, Fehlings MG. Role of screening tests for deep venous thrombosis in asymptomatic adults with acute spinal cord injury: an evidence-based analysis. Spine 2007;32:1908-16.
3. Geerts WH, Jay RM, Code KI, Chen E, Szalai JP, Saibil EA, et al. A comparison of low-dose heparin with low-molecular-weight heparin as prophylaxis against venous thromboembolism after major trauma. N Engl J Med 1996;335:701-7.
4. Meythaler JM, DeVivo MJ, Hayne JB. Cost-effectiveness of routine screening for proximal deep venous thrombosis in acquired brain injury patients admitted to rehabilitation. Arch Phys Med Rehab 1996;77:1-5.
5. Wahl WL, Ahrns KS, Zajkowski PJ, Brandt MM, Proctor M, Arbabi S, et al. Normal D-dimer levels do not exclude thrombotic complications in trauma patients. Surgery 2003;134:529-32; discussion 532-3.